The Application of Soft X-ray Microscopy to the *in-situ* Chemical Analysis of Ancient Spores in Organic-Rich Sedimentary Rocks	X1A

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Soft X-ray Imaging and C-NEXAFS has been used for the in-situ analysis of spores in a rank variable suite of organic rich sedimentary rocks. The acquisition of chemically based images (contrast based on the intensity of the 1s-pi $*$ transition of unsaturated carbon), reveals a homogeneous chemical structure in the spore exine (cell wall). C-NEXAFS microanalysis indicates the path of chemical-structural evolution of the sporopollenin bio/geopolymer with increasing thermal maturity. The most significant change in the C-NEXAFS spectrum is an increase in the con-centration of unsaturated carbon, presumably aromatic, with maturity. Increases in the concentraion of unsaturated carbon are paralleled by losses of aliphatic and hydroxlyated aliphatic carbon components. Carboxyl groups are present in low and variable concentrations. Absorption due to carboxyl groups persists in the most mature specimen in this series. The results of this study reveal that the reactions that drive sporopollenin chemical structural evolution during thermal maturation are consistent with sequential dehydration, Diels-Alder cyclo-addition, and de-hydrogenation reactions that ultimately lead to a progressively aromatized bio/geopolymer. This chemical-structural evolution pathway is different than what has been determined for other organic constituents in these rocks.

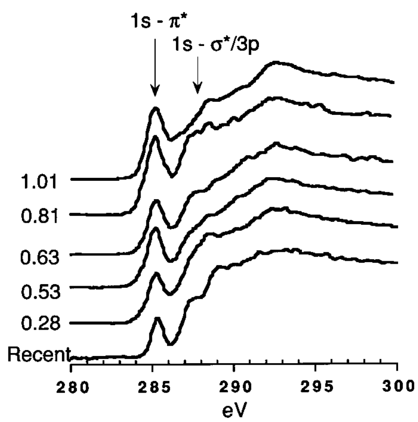

Figure 1. A Soft X-ray Image of a micro-spore in ancient sediments($\sim$ 90 MA). Contrast is based on absorption intensity at 285.5 eV, which corresponds to the 1s-pi$*$ transition of aromatic carbon.

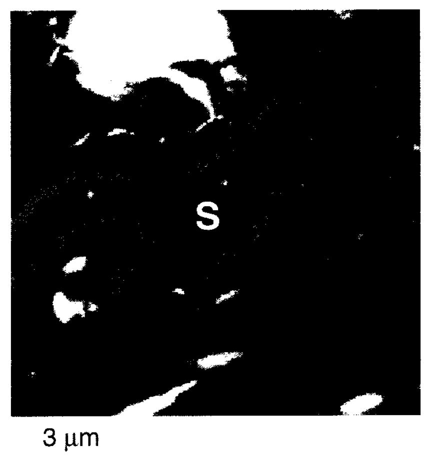

Figure 2. A Stack plot of the C-NEXAFS spectra for micro-spore samples in a suite of samples ranging in thermal maturity. Thermal maturity is gauged by the magnitude of the reflectance (%R) of a co-existing organic phase in each sedimentary rock.